

A Longitudinal Examination of Outcome Expectancy Constructs  
and their Role in Type 1 Diabetes in Youths

BY

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ABSTRACT: This study was designed to test the associations between outcome expectancy constructs (i.e., hope, optimism, and self-efficacy) and health outcomes (i.e., HbA1c and self-monitored blood glucose [SMBG]) among youths with type 1 diabetes mellitus. It was hypothesized that hope, optimism, and self-efficacy would be significantly associated with each construct in longitudinal models, such that outcome expectancy constructs would statistically predict change in health outcomes approximately 6-months after baseline assessments. 110 participants (mean age = 13.6) completed the Children's Hope Scale (CHS), the Life Orientation Test-Revised (LOT-R; optimism measure), and the Self-Efficacy for Diabetes Scale (SED), and their HbA1c and SMBG data were obtained from chart review during their clinic visit. 81 of the original 110 participants completed the assessment battery at time 2 (6-month follow-up). Confirmatory factor analyses were conducted on all measures, and the results confirmed the factor structure of the CHS and the LOT-R, but did not support the factor structure of a three-factor model, or more parsimonious one-factor model. The limited follow-up data restricted statistical power for tests of longitudinal associations using structural equation modeling (SEM), but a cross-sectional model using baseline data indicated a significant association between the CHS and HbA1c. Two baseline mediation models were also significant, suggesting that both the CHS and the LOT-R have significant indirect associations with HbA1c through a mediator, SMBG. Post-hoc analyses tested longitudinal associations using hierarchical multiple regression (which requires less statistical power than SEM analyses), and these analyses supported significant associations between change in CHS scores and change in HbA1c and SMBG data. This study provides further evidence of significant associations between hope and health outcomes in youths. Clinicians and researchers may benefit from incorporating hope in clinical assessments, and testing the benefit of hope-based intervention efforts in future clinical studies.

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Type 1 diabetes mellitus (T1DM) is one of the most common chronic illnesses in youth, with an estimated prevalence of about 1.8 cases per 1,000 youth (Lawrence et al., 2006) and an estimated 15,600 youth newly diagnosed with T1DM every year (Centers for Disease Control and Prevention [CDC], 2011). T1DM affects the body's ability to regulate blood glucose as a result of insulin insufficiency and has a number of immediate negative physiological outcomes including ketoacidosis, hypoglycemia, and hyperglycemia (Diabetes Control and Complications Trial Research Group [DCCT], 1993). In addition, T1DM is associated with a number of long-term complications such as heart disease, stroke, kidney failure, and nerve damage (DCCT, 1993, 1994). The risk of death for individuals with diabetes is about twice that compared to same-age individuals without diabetes (CDC, 2011).

Beyond these negative physiological sequelae, T1DM is also related to a variety of negative psychological states and long-term mental health problems. For example, youths with T1DM are more likely than their peers to be diagnosed with depressive disorders, anxiety disorders, and adjustment disorders, and are more likely to have peer relationship difficulties and problems in their family environment (Fogel & Weissberg-Benchell, 2010; Northam, Matthews, Anderson, Cameron, & Werther, 2005). A study of adolescents with T1DM found that one-third had psychiatric disorders, with most involving internalizing symptoms (Blanz, Rensch-Riemann, Fritz-Sigmund, & Schmidt, 1993); other studies have shown that youths with T1DM have greater rates of depression than youths without T1DM (Kovacs, Goldston, Obrosky, & Bonar, 1997), and those with depression have poor glycemic control (Hassan, Loar, Anderson, & Heptulla, 2006). Moreover, a number of longitudinal studies has documented a higher risk of long-term self-esteem problems, depressive disorders, and psychosocial problems—some persisting into adulthood (Bryden, Peveler, Stein, Neil, Mayou, & Dunger, 2001; Jacobson, Hauser, Willett,

Wolfsdorf, Herman, & de Groot, 1997; Kovacs et al., 1997). Many children also have adjustment problems within the first few months after their diagnosis (Laffel et al., 2003). Although the majority of these adjustment problems resolve within the first year, children who do not resolve these problems are at risk for poor adaptation to T1DM, including regimen adherence problems, poor metabolic control, and continued psychosocial difficulties (Graue et al., 2004; Hood et al., 2006; Seiffge-Krenke et al., 2003). These psychosocial problems may also lead to increased health care utilization and missed school or work (e.g., parents taking off to transport their children), contributing to increased health care costs and financial burden related to T1DM (Stewart, Rao, Emslie, Klein, & White, 2005; Tao & Taylor, 2010).

Research also indicates that youths with T1DM, particularly adolescent girls, are at increased risk for eating disorders. Both eating disorders and subclinically disordered eating attitudes and behaviors (i.e., severe dietary indiscretion and repeated insulin omissions) have been observed in adolescent girls with T1DM and are associated with poorer metabolic control (Peveler et al., 2005; Neumark-Sztainer et al., 2002). Some research suggests that at least 10% of adolescent girls with T1DM meet diagnostic criteria for an eating disorder, a rate twice as common as in girls without T1DM (Jones et al., 2000). Without intervention, disordered eating and insulin manipulation may worsen over time and increase the risk of later health complications (Peveler et al., 2005).

Unfortunately, various psychosocial factors, disruptive behavior disorders, and disruptive family environments have also been associated with youths' medical management of their T1DM (Helgeson, Siminerio, Escobar, & Becker, 2009). For example, in a recent longitudinal examination, Helgeson and colleagues (2009) found that eating disturbances, depression, and poor peer relations were associated with poor metabolic control in youths. Grey and colleagues

(2002) noted similar findings in T1DM indicating a consensus regarding the relationship between depression and poor diabetes management. Other research suggests that individuals with better metabolic control report a higher quality of life (de Wit et al., 2007; Nardi et al., 2009), and that individuals with good glycemic control and high quality of life monitor their blood glucose more frequently and report lower levels of negative affect (Ingerski, Laffel, Drotar, Repaske, & Hood, 2010).

A frequent contributor to poor metabolic control, particularly among youths with psychosocial issues, is youth non-adherence to medical regimens, including self-monitored blood glucose, insulin dosing, a healthy diet, and exercise, among others (Silverstein et al., 2005). The extent of nonadherence in T1DM varies considerably, with estimates of between 20% and 93% across various age ranges (Rapoff, 2010; Wysocki, Buckloh, Lochrie, & Antal, 2005). More specifically, although it is recommended that youth check their blood glucose levels at least four times daily, research suggests that youth may be checking their blood glucose less than 3 times per day, on average (Guilfoyle, Crimmins, & Hood, 2011). Youths also have difficulties maintaining a healthy diet, exercising regularly, and using insulin effectively. Despite the recommended goal to achieve HbA1c levels <8.0%, research indicates that mean HbA1c levels among youths frequently exceed this recommendation (~8.9% in youths 12-18; Danne et al., 2001; Mortensen et al., 1998).

In response to the challenges associated with managing T1DM, many behaviorally-based interventions have been designed and implemented to improve adherence and metabolic control, as education and routine counseling from medical health professionals (e.g., medical doctors, nurses, etc.) are not always sufficient (Hood, Rohan, Peterson, & Drotar, 2010). A recent meta-analysis indicates that interventions aimed at increasing adherence have a small pre- to post-



treatment effect on HbA1c, with a mean effect size of 0.11 (Hood et al., 2010). Additionally, given the various psychosocial sequelae associated with T1DM, several family-based treatment approaches have been designed to target outcomes in these areas. Similar to the literature on HbA1c levels (e.g., Hood et al., 2010), family interventions have demonstrated limited effects on psychosocial outcomes (Channon et al., 2007; Grey et al., 2009; McNamara et al., 2010; Mulvaney et al., 2010; Whittemore et al., 2010).

Many of the above referenced interventions have incorporated outcome-expectancy and outcome-cognition components as purported “active ingredients” in the intervention (Channon et al., 2007; Grey et al., 2009; Hood et al., 2010; McNamara et al., 2010; Mulvaney et al., 2010; Whittemore et al., 2010). For example, interventions based on social cognitive theory, specifically designed to improve adolescents’ confidence in self-management and outcome expectancy (e.g., self-efficacy, optimism), have been shown to improve HbA1c, confidence in diabetes control, and other psychosocial outcomes in the short-term and at 1-year follow-up (Ambrosino et al., 2008; Nansel et al., 2007; Nansel et al., 2009; von Sengbusch et al., 2005). Further, psychoeducational interventions (e.g., interventions targeting improved disease knowledge, management, and individualized coping) have been designed for children and their families that utilize components similar to those in hope theory, such as promoting problem-solving skills for goal attainment and increasing intrinsic motivation for change (Channon et al., 2007; Grey et al., 2009; McNamara et al., 2010; Mulvaney et al., 2010; Whittemore et al., 2010). Overall, these interventions have demonstrated improvements in problem-solving, self-management, quality of life, and glucose control with effect sizes ranging from 0.12 to 0.24 for various outcomes (e.g., Channon et al., 2007; Mulvaney et al., 2010).

The outcome expectancy constructs mentioned above (i.e., hope, optimism, and self-efficacy) are also common components included in analyses of behaviors and adaptation in other health contexts. More specifically, hope has demonstrated significant associations with adults' and youths' responses and coping to a variety of chronic health problems (Cheavens et al., 2005). As originally theorized by Snyder (1991), hope theory refers to an individual's energy and planning toward goal attainment. According to Snyder's conceptualization of hope (2002), and confirmed by later factor analysis (Brouwer, Meijer, Weekers, & Baneke, 2008), hope is comprised of two interactive components (pathways and agency) that make up an overall hope construct. *Pathways* represent the routes individuals select to achieve their desired goals (i.e., the means to an end). *Agency* refers to an individual's goal directed energy, intention, and persistence (i.e., motivation to set and complete goals). Explaining the associations between hope and health outcomes, Snyder and colleagues (1997) hypothesized that high-hope people with medical illness would devote many of their goal-directed thoughts to their illness adjustment or the various aspects involved in the treatment of their illness. These proactive thoughts may then lead to the implementation of helpful strategies and the prevention of other goal-impediments that could interfere with illness recovery.

Among adults, hope has been shown to predict psychological and psychosocial adjustment among breast cancer patients, individuals with visual impairment, familial cancer experiences, and heart failure (Irving et al., 1998; Jackson et al., 1998; Rustoen et al., 2005; Stanton, 2000). In college women with familial cancer experiences, higher-hope scores predicted more active, hope-related coping (Irving et al., 1998). Similarly, among individuals with visual impairment, high-hope scores were associated with more sociable, proactive coping styles and higher levels of self-reported ability (Rustoen et al., 2005).

While less often studied, hope has also been shown to be correlated with medical outcomes among children and adolescents. For example, among adolescent burn victims (aged 13-19 years), hope negatively predicted externalizing behaviors and was positively associated with global self-worth (Barnum et al., 1998). In addition, Maikranz and colleagues (2007) found that hope was related to depressive symptoms and anxiety in a sample of renal and liver transplant recipients between the ages of 7-18 years. Specifically, children with high-hope (and low levels of illness-related uncertainty) were more likely than their counterparts to be adherent to medical regimens after transplantation, provided that they were not reporting depressive symptoms at the time. Similarly, Berg and colleagues (2007) found hope to be a significant predictor of treatment adherence among children 8 to 12 years old diagnosed with moderate to severe asthma. In the diabetes literature, Lloyd and colleagues (2009) reported a significant association between hope, regimen adherence and glycemic control (HbA1c) for adolescents 13-17 years old, and found that hope mediated the relationship between perceived maternal empathy and adherence, and between perceived maternal empathy and glycemic control.

In contrast to hope theory, which is argued to be more specific to an individual's strategies and motivation toward goal-attainment, optimism represents a construct describing an individual's general expectancy for good rather than bad outcomes in their life (Scheier & Carver, 1985). This theory of optimism was described as a trait-like unidimensional framework, in which optimism is at one end of the spectrum and pessimism (i.e., a belief that bad rather than good outcomes await) is at the other end. Within this conceptualization, it is hypothesized that dispositional optimism influences psychological well-being by promoting a positive outlook in challenging situations and limiting negative interpretations of events. Numerous researchers (Rasmussen et al., 2009; Scheier et al., 1999) have theorized that optimism may play a role in

health outcomes, stating that individuals high in optimism will be better able to cope with the setbacks inherent in disease management, and be more likely to avoid the spiraling effects of negative thoughts and feelings on health outcomes. Optimistic individuals are hypothesized to have more energy to engage in difficult behaviors due to their positive cognitive patterns (Scheier & Carver, 1985).

Among adults, Brennan and Spencer (2010) found that optimism was significantly associated with oral health, such that adults with higher levels of optimism also had fewer missing teeth and were less likely to report that their oral health had negative influences on their quality of life. Also among adults, Fournier and colleagues (2002) found that optimism was significantly and positively associated with emotion-focused coping and significantly negatively associated with self-reported physical symptoms among individual with diabetes, rheumatoid arthritis, and multiple sclerosis. The authors noted that the relations between optimism and coping did not depend on the controllability of the chronic disease. In other words, associations between optimism and coping were just as strong for less controllable diseases (i.e., less directly impacted by medical adherence) like multiple sclerosis as they were for diseases that are more controllable (such as diabetes). Moreover, Steptoe and colleagues (2006) have found that optimism was significantly associated with physical activity and smoking avoidance in adults, while Achat and colleagues (2000) found that optimism was associated with lower levels of physical pain.

In research involving youths, Mannix and colleagues (2009) found support for an association between optimism and health-related outcomes in a sample of participants ages 13-21 years old with cancer. They found that optimism was significantly associated with less self-reported pain, better communication with health-care providers, higher reported psychosocial

functioning, and higher quality of life. Wright (1997) reported that optimism was associated with diabetes-specific psychological adjustment in a group of adolescents ages 12-17 years. Wright also reported a significant association based on regression equations between optimism and psychosocial competence, diabetes regimen adherence, adolescent responsibility for their treatment regimen, and metabolic control.

As distinguished from hope theory and optimism, self-efficacy is a domain-specific construct that is theorized to comprise one's confidence in his or her ability to complete a task in a given context. It constitutes two primary components: outcome expectancies and efficacy expectancies. *Outcome expectancy* refers to an individual's understanding of the actions required in order to produce a specific outcome or desired end-state. Outcome expectancies are general perceptions of the consequences of various behaviors. Of greater impact to an individual's life (in Bandura's opinion) are efficacy expectancies; *efficacy expectancies* refer to the perception of how well one is equipped to carry out the requisite actions for specific outcomes (Bandura, 1977). In the health context, authors have hypothesized that individuals high in self-efficacy may be more likely to report that they are very confident in their ability to make health-behavior change, to take their medication, or communicate their concerns or questions to health professionals (Bandura, 1997; DeVellis & DeVellis, 2001). Because of its domain-specific nature, health-related self-efficacy measures are generally tailored to specific chronic illnesses and the adherence, social, and familial skills that are common and/or unique to managing those specific illnesses.

Research in the health context has demonstrated a variety of associations between self-efficacy and outcomes in cancer, type 1 diabetes, smoking cessation, physical activity, dietary behavior, and others (Reuter et al., 2010). Grossman and colleagues (1987) conducted one of the

first investigations of self-efficacy and its relation with T1DM outcomes as part of a validation study of a self-efficacy measure for youth with type 1 diabetes. The authors reported significant associations between self-efficacy and frequency of blood glucose monitoring, and between self-efficacy and average blood glucose. In a similar investigation, Griva and colleagues (2000) found significant associations between self-efficacy and adherence to diet and blood glucose monitoring, and between self-efficacy and HbA1c in a sample of participants from the United Kingdom aged between 15 and 25 years. Moreover, Iannotti and colleagues (2006) found that self-efficacy was significantly related to both parent- and youth-reported self-management (based on parent and youth report on the Diabetes Self-Management Profile) of diabetes in a sample of 13- to 16-year-olds, and self-efficacy interacted with diabetes outcome expectancies (a construct built from optimism theory) as significant predictors of HbA1c outcomes in a regression equation. Chih and colleagues (2010) reported similar results in a sample of Taiwanese adolescents; in this study, self-efficacy was statistically predictive of HbA1c in youths 12-20 years old. They also noted that individuals with high self-efficacy were 1.63 times more likely to reach target HbA1c levels (<7%) than individuals who reported low self-efficacy.

Following research demonstrating an association between emotions and T1DM outcomes (Grey et al., 2002; Wiebe et al., 2005), Fortenberry et al. (2009) reported that the association between positive and negative affect and HbA1c was mediated by self-efficacy, providing support for self-efficacy's role as a mechanism in the relation between emotions and health outcomes for children with type 1 diabetes. Palmer and colleagues (2009) examined self-efficacy's interaction with T1DM care responsibility with regard to HbA1c levels in a sample of adolescents 10-14 years old. Their results suggest that both adolescent and parent self-efficacy are significantly associated with HbA1c, and that self-efficacy interacted with responsibility such

that adolescents with low diabetes self-efficacy had lower HbA1c if their parents took more responsibility of their care. On the other hand, higher levels of adolescent diabetes self-efficacy were associated with lower levels of HbA1c if they were primarily responsible for their own care. Similarly, Berg and colleagues (2011) found that self-efficacy mediated the association between parent-child relationships and HbA1c outcomes, and also mediated the association between parental monitoring and adherence in a sample of 10-14 year olds.

### **Distinctions and Similarities Between Hope, Optimism, and Self-Efficacy**

As theorized by Snyder (2002), hope theory is distinct from optimism through the measurement of, and equal weight given to, an individual's pathways; that is, hope theory intends to assess one's capacity to select appropriate routes and overcome barriers to goals rather than just one's confidence in their ability to move toward desirable goals (i.e., optimism, as described by Scheier & Carver, 1985). Snyder (2002) differentiated hope from self-efficacy primarily through his distinction between "can" and "will"; in this way, hope is hypothesized to measure one's intention to start and achieve a goal rather than just confidence in one's ability to complete the goal (i.e., self-efficacy). One can likely imagine interacting with individuals that were very confident in their abilities to be successful in certain contexts, but may have lacked the requisite skills necessary to actually succeed in those situations; in other words, one may be confident that they could do something, but they may not be confident that they *will* do something. In addition, Snyder (2002) points out that hope is a general dispositional construct rather than the situation-specific construct, self-efficacy, hypothesized by Bandura (1977).

Beyond the theoretical differences described above, research comparing hope to other similar constructs has provided support for the uniqueness of hope theory (compared to similar constructs) in its relationship with various outcomes in adult populations. For example, Bryant

and Cvengros (2004) found that optimism (but not hope) was associated with the use of positive reappraisal as a coping strategy, whereas hope (but not optimism) was associated with levels of general self-efficacy. More recently, agency was the strongest predictor of life satisfaction in samples of university students and adults compared to optimism, pessimism, and pathways in backward multiple regression analyses (Bailey, Eng, Frisch, & Snyder, 2007). In addition, Magaletta and Oliver (1999) found that overall hope scores accounted for unique variance in subjective well-being beyond self-efficacy and optimism (included together in regression analyses) in a sample of university students. Specifically, multiple regression analyses demonstrated that agency contributed uniquely to well-being beyond self-efficacy, and pathways contributed uniquely to well-being beyond optimism. These studies suggest that hope (and subcomponents of hope) may have a pattern of associations with some outcome variables that is discrepant from that of conceptually similar constructs.

Despite significant research on the associations between hope and outcomes in numerous contexts, there is still confusion regarding hope's conceptualization among laypeople. Hope is often interpreted as nearly synonymous with optimism despite numerous theorized differences in the psychological literature. Furthermore, researchers such as Aspinwall and Leaf (2002), Peterson and Seligman (2004), and Tennen et al. (2002) have noted that hope theory's similarity to other constructs is significant enough to call into question its distinctiveness as a construct. Aspinwall and Leaf (2002) suggested that the word "optimism" could take the place of the word "hope" in theoretical descriptions and be indistinguishable as constructs. Moreover, empirical investigations that have included both hope and optimism have noted considerable overlap, with Pearson correlations ranging from .50 to .60 (Magaletta & Oliver, 1999; Snyder et al., 1991) and correlations among second order latent factors of .80 (Bryant & Cvengros, 2004). Recent



investigations regarding hope's factor structure in comparison with optimism indicate that a second-order (i.e., higher-order) factor comprised of indicators from both constructs provides good fit to the data (Bryant & Cvengros, 2004; Rand, 2009). In fact, Rand noted that although two-factor single-order models also fit the data well, only the second-order factor was directly associated with study outcomes.

In addition, some (e.g., Tennen et al., 2002) have suggested that hope is also remarkably similar to self-efficacy theory and have questioned whether hope contributes uniquely or incrementally to outcomes in comparison to self-efficacy. For instance, Magaletta and Oliver (1999) compared hope to a generalized version of self-efficacy and found that agency items from the Adult Hope Scale have considerable overlap with general self-efficacy items. They noted that subscale differences may be driving the differences in associations with outcomes between self-efficacy and hope given that agency items contributed more unique variance to the analyses than did pathways items.

In one of the few investigations comparing hope to similar constructs in children, Wong and Lim (2009) found that both optimism and hope accounted for unique variance in predicting depression and life satisfaction in a sample of Singaporean adolescents. A comparison between the correlations of hope with outcome measures and the correlations of optimism with outcome measures was not statistically significant. Overall, the authors concluded that hope and optimism were more similar than different in regard to their predictive validity for outcomes in this particular sample. Similarly, Vacek and colleagues (2010) found that optimism and self-esteem had a larger association with life satisfaction than hope in a sample of urban ethnic-minority adolescents (61.2% Hispanic/Latino). Interestingly, while optimism and self-esteem were

significantly and positively associated with life satisfaction, hope's association with life satisfaction was non-significant and in the negative direction.

### **Justification and Aims for the Present Study**

This study is designed to build upon the above-mentioned research regarding hope, optimism, and self-efficacy in a number of ways. Overall, research indicates mixed findings regarding the differential associations of hope, optimism, and self-efficacy with pediatric health outcomes. In fact, the extant research in youths has reported considerable overlap between constructs in one study (Wong & Lim, 2009), and results inconsistent with a majority of the adult research in another study (i.e., optimism predicting outcomes beyond hope; Vacek et al., 2010). It may be the case that these three constructs share considerable overlap in youth populations such that they are nearly indistinguishable, or that optimism or self-efficacy are more strongly associated with health outcomes in comparison to hope. At this point, generalizations regarding these constructs in youths are difficult to make given the lack of research comparing hope, self-efficacy, and optimism in youth samples.

In addition, although these constructs have been included in health-based research, a majority of this research has been conducted utilizing cross-sectional designs. Generalizations and inferences are limited from cross-sectional designs because these designs do not allow researchers to test for the temporal stability of associations between exogenous predictors and health measures, and they are less reliable at identifying potentially important predictors of change in outcomes. Finally, although a considerable research base exists regarding self-efficacy's relation to outcomes in the T1DM context, little research has included hope or optimism in these examinations.

The present study was designed to address these limitations by prospectively examining the associations between hope, optimism, and self-efficacy and health outcomes in a sample of youths with T1DM. With regard to health outcomes, limited research is available regarding the longitudinal associations between hope, self-efficacy, and optimism with adherence measures and metabolic control together in the same study. An analysis of adherence and metabolic control together in a comprehensive model may be beneficial given that there is considerable distinction between the two outcomes as they are currently measured. For instance, recent research suggests that adherence is not consistently associated with metabolic control (Hood, Peterson, Rohan, & Drotar, 2009), indicating that it may not be appropriate to examine just one outcome measure in diabetes research. Hood et al. point out that glycemic control is multiply determined, and that factors such as growth, puberty, and psychosocial variables all play a role in measured HbA1c. Thus, Hood and colleagues (2009) recommended that both adherence and glycemic control should be considered as primary outcome measures of diabetes management.

Given that preliminary evidence demonstrates an association between each construct and health outcomes generally and diabetes specifically (Chih et al., 2010; Griva et al., 2000; Lloyd et al., 2009; Wright, 1997), and previous research does not provide a justification for an incremental association with health outcomes from either of the three constructs, the present investigation did not hypothesize a constrained model with regard to outcome expectancy constructs. That is, the primary study hypothesis was that hope, optimism, and self-efficacy scores at baseline would be statistically significantly associated with health outcomes (i.e., self-monitored blood glucose and HbA1c) in youths at Time 2.

Moreover, because few investigations have assessed relations between these constructs and health outcomes longitudinally, this investigation tested the cross-lagged direction of

associations between hope, self-efficacy, optimism and the hypothesized outcomes. This determination of directionality between these constructs and health outcomes was warranted given that previous research has incorporated these constructs as both predictors and outcome variables, providing little evidence to the direction of association (Bryant & Cvengros, 2004; McNeal et al., 2006; Weis & Ash, 2010). Thus, if study results suggest that it may be more appropriate to consider these constructs as predictors of health outcomes, then interventions could be designed to increase hope, self-efficacy, and optimism in order to confer subsequent health benefits. On the other hand, if results suggest that it may be more appropriate to consider these constructs as outcome variables in the health context, then future research may benefit from examining whether hope, self-efficacy, and optimism are associated with later health benefits (e.g., as mediators of change) by including additional time points in longitudinal investigations. Nonetheless, it was hypothesized that hope, optimism, and self-efficacy would significantly predict residual change in health outcomes behaviors.

In addition, and considering the construct similarities previously noted in youth research (Wong & Lim, 2009), an important exploratory aim of this study involved testing the model fit of a hypothesized second-order (i.e., higher-order) latent construct comprised of hope, self-efficacy, and optimism, and was labeled *outcome expectancy*. An examination of this kind would potentially provide a more parsimonious construct to be included in later research involving latent modeling. In addition, it would suggest that these three constructs share an underlying structure in youth conceptually similar enough to be “driven” by a unifying latent construct. This result could then advance future theoretical considerations regarding hope, self-efficacy, and optimism as they relate to pediatric health outcomes and inform future measure development or revision (e.g., a higher-order model factor analyzed in a community sample). Following the

confirmation of the higher-order model through confirmatory factor analysis, the associations between the latent construct *outcome expectancy* and health outcomes were examined.

## **Methods**

### **Participant Recruitment**

Parent-youth dyads were eligible to participate if youths were between the ages of 10-16 years old, youths had been diagnosed with T1DM for at least 6 months, and the family was English-speaking. Families were excluded if youths had a diagnosis of developmental delay (i.e., autism, cerebral palsy, or mental retardation) and if youths or parents reported hospitalization within the last year for a psychological disorder. Study personnel recruited participants (parent and youth dyads) from the Pediatric Diabetes Center (PDC) at the University of Kansas Medical Center (KUMC), through an affiliated office in Salina, and at the Diabetes Center at Children's Mercy Hospitals and Clinics.

A power analysis was conducted in order to evaluate the number of participants necessary to test study hypotheses using structural equation modeling. This power analysis was based on an expected ability to detect at least a 0.25 correlation between youth psychosocial measures and HbA1c and self-monitored blood glucose. Previous research has demonstrated an association between hope and HbA1c at  $r = 0.39$  (Lloyd et al., 2009), and between youth self-efficacy (as measured by the Self-Efficacy for Diabetes Scale) and HbA1c ( $r = 0.51$ ) and self-monitored blood glucose ( $r = 0.42$ ) (Griva et al., 2000). Although these results provide potential parameters for power estimates, the limited number of studies that have reported on associations between these measures and diabetes outcomes provide only tenuous predictions of associations. Thus, this study used a more conservative estimate for parameter associations in the structural model, set at  $r = 0.25$ . Given this parameter with alpha set at 0.05 and power set at 0.80, a sample

size of approximately 100 participants was identified as the minimum needed to detect a significant correlation between psychosocial variables and adherence/ HbA1c at time 2. The final estimate of 100 participants was calculated based on an expected attrition rate of 20% at Time 2 from the sample of 125 participants at Time 1; previous intervention studies have found lower attrition rates ranging from 0% to 4% (Grey et al., 2001; Nansel et al., 2009; Nguyen et al., 2008), though those retention numbers may have been influenced by the relationship established between intervention providers and participants. Nevertheless, this investigation had the potential advantage of being able to coordinate data collection with hospital visits, and the option to complete measures via internet-based electronic databases.

## **Procedure**

Study aims and procedures were approved by the institutional review boards of the University of Kansas, the University of Kansas Medical Center, and Children's Mercy Hospitals and Clinics. Each of these institutions entered into an Agreement Regarding the Use of Data which, for the purposes of this study, provided the dissertation student with access to specified portions of data from a large multisite study. Dyads who consented to participate in the research database and the prospective study were asked to sign an informed consent and assent form, and were informed that this study involved completing study measures and providing HbA1c and self-monitored blood glucose (SMBG) data at two time points (baseline [Time 1] and 6-month follow-up [Time 2]). The study was originally designed to obtain dyads' email addresses during clinic visits following assent/consent from clinic personnel, and to subsequently email instructions for accessing a secured internet study site to complete the assessment battery. Among the first 29 participants recruited in this manner, 5 participants did not complete study measures. In order to improve participant response, study personnel recruited participants to

complete the web-based study measures using iPads while they were present in clinics for scheduled visits. A measure of youths' frequency of self-monitoring for blood glucose (SMBG) was obtained from meter downloads collected from youths' medical chart. Youths' HbA1c data were obtained through chart review. Approximately six months post-baseline (Time 2) all dyads were asked to complete the assessment battery and study personnel gathered blood glucose meter data and HbA1c data via a second chart review. Parents and youth were each compensated \$25 for both assessment time points completed. Thus, if families completed all data points, they earned \$100 for participating in the prospective study.

## **Measures**

*Optimism.* The revised Life Orientation Test (LOT-R; Scheier et al., 1994) is a 10-item measure (six items measuring optimism plus four filler items) of dispositional optimism (e.g., "In uncertain times, I usually expect the best"). The LOT-R was originally validated in samples ranging from 18-82 years-old, but has been used reliably in youth samples (Mannix et al., 2009; Puskar et al., 1999; Wong & Lim, 2009). Respondents are asked to rate the extent of their agreement to these items using a five-point Likert-type scale ranging from 0 (strongly disagree) to 4 (strongly agree). The LOT-R is a revised version of the LOT (Scheier & Carver, 1985), and it has been found to correlate 0.95 with the original scale (Scheier et al., 1994). Higher scores on the LOT-R indicate greater levels of optimism. Cronbach's alpha for the LOT-R has been calculated at 0.82 in past research (Scheier et al., 1994). For this study, the Cronbach's alpha was 0.83.

*Hope.* The Children's Hope Scale (Snyder et al., 1997) is based on the Trait and State Hope Scales (Snyder et al., 1991; Snyder et al., 1996), which were originally aimed to assess two main components of goal-directed thinking: agency and pathways. The CHS is a 6-item self-

report instrument designed for children and adolescents 8-16 years old, and is administered with a Likert response continuum ranging from “None of the time” to “All of the time.” The CHS is divided into 3 items that measure agency and 3 items that measure pathways. A higher total score on the CHS reflects greater overall hope. The CHS has demonstrated good internal consistency, with Cronbach’s alphas ranging between 0.72 and 0.86 (Snyder et al., 1997). The Cronbach’s alpha for this study was 0.76.

*Self-efficacy.* The Self-Efficacy for Diabetes Scale (SED) is designed to assess youths’ (12-16 years-old) perceptions of their ability to manage diabetes (Grossman, Brink, & Hauser, 1987). Adolescents reported their level of confidence in being able to accomplish important aspects of diabetes management using a 35-item scale. Items such as “avoid having low blood sugar reactions” were rated on a 6-point scale ranging from 1 (*very sure I can’t*) to 6 (*very sure I can*). Based on previous research, internal consistency for this measure is good (Cronbach’s alpha = 0.89; Grossman et al., 1987). The SED was selected for this study over other measures of diabetes self-efficacy because it had the potential to assess for general self-efficacy in addition to diabetes self-efficacy, which would allow for comparisons between outcome expectancy constructs that are not context specific. For this study, the Cronbach’s alpha was 0.86.

*Glycated Hemoglobin (HbA1c).* Glycated hemoglobin, or HbA1c, is a measure of the amount of hemoglobin in an individual’s blood that has interacted with glucose and reflects an approximation of average glucose over a period of approximately three months with results over the last four weeks contributing heavily to this number (American Diabetes Association, 2008). In individuals diagnosed with T1DM, this number is elevated when compared to individuals without diabetes. Physicians recommend that children and adolescents with T1DM aim for HbA1c levels less than 8% (in children 6-12 years old) or 7.5% (in adolescents 13-19 years old)



given the increased potential for hypoglycemia in children and adolescents (Silverstein et al., 2005). As noted previously, HbA1c was obtained through chart review from the most recent care visit.

*Self-Monitored Blood Glucose (SMBG).* Self-monitored blood glucose refers to the number of blood glucose values recorded by the youth's blood glucose meter for an individual day, values which are generally downloaded from the meter at diabetes clinic visits. This information is important to both youths and doctors because insulin dosing decisions are influenced by SMBG, and previous research has demonstrated an association between the frequency of SMBG and glycemic control (i.e., HbA1c; Anderson et al., 1997). It is recommended that youths with diabetes check their glucose levels at least four times per day in order to effectively manage their insulin dosing and instances of hyperglycemia and hypoglycemia (American Diabetes Association, 2004). Similar to HbA1c data, SMBG was obtained through chart review of families' most recent clinic visit.

### **Data Analyses**

Descriptive analyses, including means, standard deviations, and frequencies, were calculated for sociodemographic variables at Time 1 and for individual scores on study measures at each time point (Time 1 and Time 2). To identify potential model covariates, Pearson correlations and independent t-tests were used to examine the relationship between sociodemographic variables (i.e., child age, gender, minority status) and scores on study measures at Time 1. Independent sample t-tests and chi-square tests were conducted to examine differences between patients with complete data at both time points (N = 81) versus those who were missing data at Time 2 (N = 29).

The most likely missing data pattern in the proposed study was “Missing Completely at Random” (MCAR). MCAR describes instances in which missing data for a particular variable is not related to any other variable of interest in the dataset, and there is no clear association between the missing data and an unobserved variable or circumstance (Rubin, 1976). For instance, if participants accidentally skip items or fail to answer items because they fail to notice a particular item, these missing values would be MCAR. If participants consistently skipped certain items because they identified as Native American or as male, for example, then the missing data would not be truly random.

The proposed study aims were analyzed utilizing structural equation modeling (SEM) in MPlus (Muthen & Muthen, 2010). This technique allows several regression equations to be analyzed simultaneously in order to generate an estimated covariance matrix. This covariance matrix then is compared to the covariance matrix of the observed data, and the closeness of fit of the estimated model to the observed data can be evaluated through several goodness-of-fit statistics. An advantage of MPlus compared to other statistical software is that it allows for the simultaneous estimation of missing data and the structural model, using ML estimation, without creating an auxiliary dataset to be used for structural analyses (Enders, 2006; Muthen & Muthen, 2010). In addition, SEM approaches allow for the estimation of higher, second-order models. For this study, the following goodness-of-fit indices were examined as tests of model fit: (a) chi-square statistic ( $\chi^2$ ); (b) root mean square error of approximation (RMSEA; Steiger, 1990); (c) standardized root-mean residual (SRMR); and (d) comparative fit index (CFI).

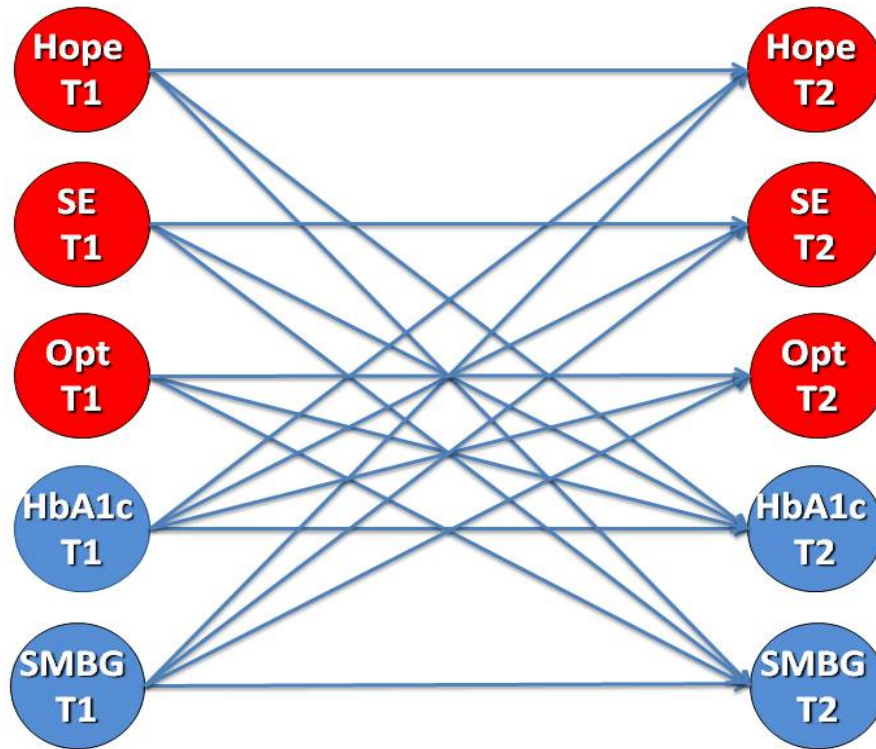
As recommended by Hoyle (1991) and Kessler and Greenberg (1981), a confirmatory factor analysis was conducted on the measurement model before any structural models were estimated. This step is necessary to confirm that the underlying measurement model is accurately

represented by the hypothesized latent constructs, and that the measurement of these latent indicators is internally reliable. This step is not necessary for measures of HbA1c and SMBG given that they are not made up of multiple indicators, and are thus assumed to be measured without error.

Following tests of model fit of each construct's measurement model, invariance across time was assessed in order to determine whether the measurement model was acceptable at both study time points. Confirmatory longitudinal invariance is confirmed by demonstrating configural invariance (i.e., estimated and fixed parameters are equivalent across time), weak factorial invariance (i.e., factor loadings are equivalent across time), and strong factorial invariance (i.e., indicator means are equivalent across time; Brown, 2006).

In order to test the first study hypothesis (i.e., that outcome expectancy constructs would be significantly associated with health outcomes), the proposed structural model was estimated (following establishment of longitudinal invariance) including Time 1 hope, optimism, and self-efficacy as predictors of the residual change (i.e., the variance at Time 2 controlled for Time 1 using autoregressive paths) in HbA1c and SMBG. As indicated in Figure 1, simultaneous associations (i.e., cross-lagged analyses) between Time 1 SMBG and HbA1c as predictors of residual change in hope, optimism, and self-efficacy were included in order to test the second study hypothesis that the outcome expectancy constructs are better conceptualized as predictors of changes in health outcomes. In addition, age was included as a covariate in the structural model given the range of ages of youths in the study, combined with previous research suggesting that adolescents have more difficulty with metabolic control compared to children (e.g., Greening et al., 2007).

Figure 1. *Cross-Lagged Model of Structural Associations between Hope, Optimism, Self-Efficacy, and Health Outcomes*

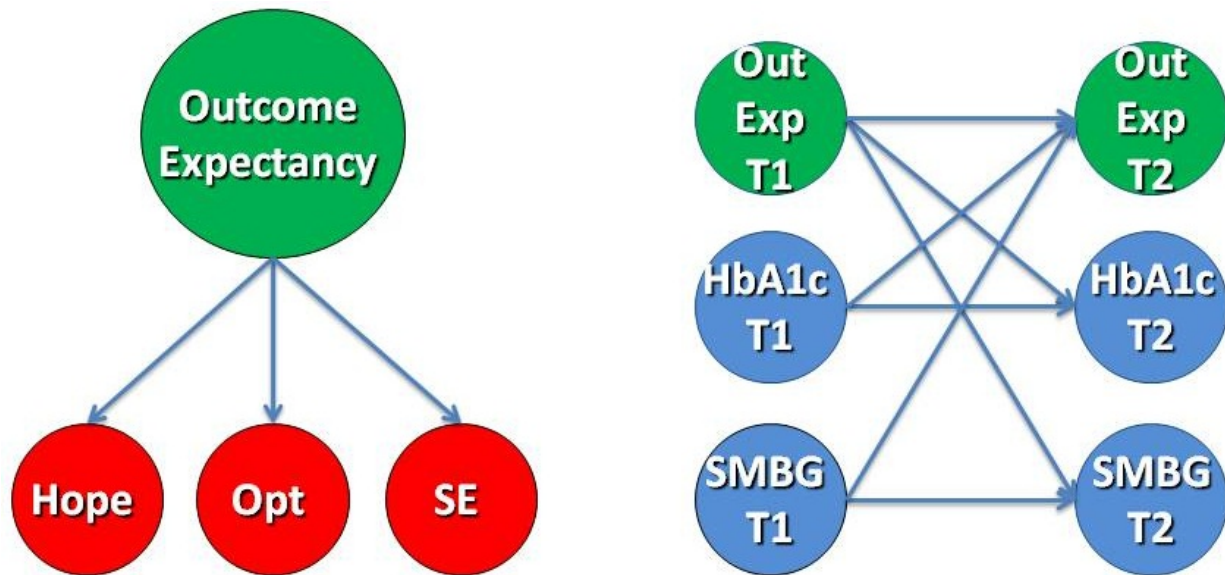


Potential post hoc modifications to models were considered by examining the modification indices provided by MPlus. These indices specify the extent to which certain parameters, if added to the model, would improve the fit of the model; this may be especially relevant when considering that any of the three outcome expectancy constructs may be associated to a higher degree than the others. Thus, nonsignificant paths were pruned from the final model in order to establish the most parsimonious model of the data.

In order to test this study's exploratory aim, a higher-order measurement model of the construct *outcome expectancy* was tested for model fit and invariance across time. If the model

demonstrated acceptable fit, structural paths with study outcomes could be estimated, as such a model would provide an even more parsimonious representation of the data.

Figure 2. *Hierarchical (Second-Order) Model of Outcome Expectancy Construct and Structural Relationships*

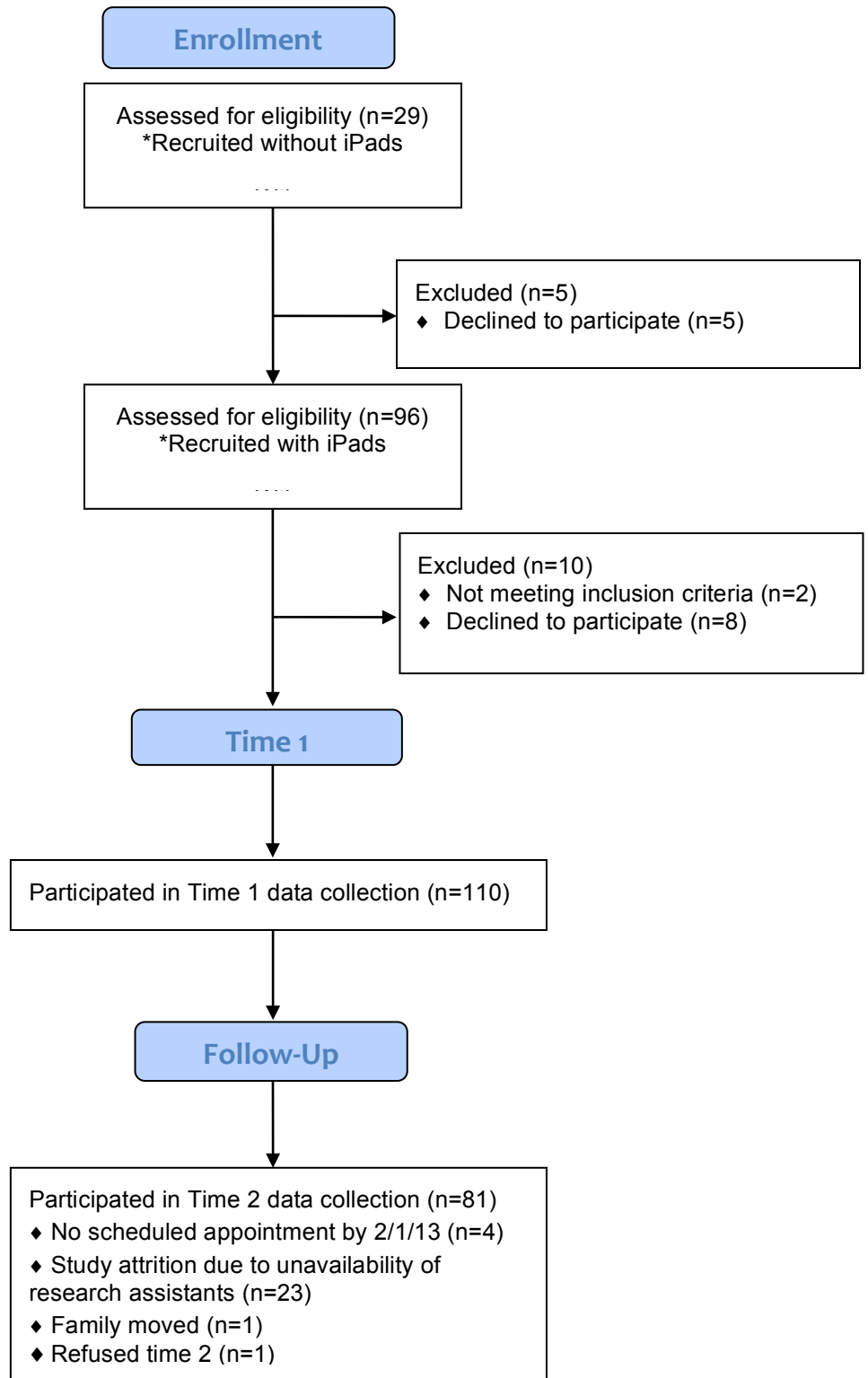


## Results

### Participants

Of the 125 dyads who were recruited and who completed consent/assent at Time 1, 110 youth with T1DM and a custodial parent completed study measures and provided HbA1c and SMBG data. Participant recruitment and retention is detailed in the consort diagram below.

## CONSORT Flow Diagram



The majority of participants at Time 1 were male (N=60; 54.5%) and Caucasian (N=98; 89.1%) and had been diagnosed with diabetes for an average of 5.6 years. Participants were between 10-16 years old ( $m = 13.6$ ). Of the original 110 participants at Time 1, 81 completed study measures and provided HbA1c or SMBG data at the follow-up visit (Time 2). A majority of these participants were male (N = 42; 51.9%) and Caucasian (N = 72; 92.3%) and had been diagnosed with diabetes for an average of 6.2 years. Participants were between 10-17 years old ( $m = 14.18$ ). Table 1 details demographic information for the sample at each time point. Means and standard deviations for the CHS, LOT-R, SED, and diabetes outcome variables are detailed in Table 2.

Table 1. *Demographic Characteristics of Participants by Assessment Point*

	Mean $\pm$ SD or $n$ (%)	
	Baseline (Time 1)	6-month follow-up (Time 2)
N	110	81
Child Age (years)	13.6 (1.87)	14.18 (1.87)
Male Child Gender	60 (54.5%)	42 (51.9%)
Child Ethnicity		
Caucasian	98 (89.1%)	72 (88.9%)
African-American	3 (2.7%)	2 (2.5%)
Hispanic	1 (0.9%)	1 (1.2%)
Asian	0 (0%)	0 (0%)
Native American	0 (0%)	0 (0%)
Mixed	3 (2.7%)	3 (3.7%)
Other	1 (0.9%)	0 (0%)
Did Not Answer	4 (3.6%)	3 (3.7%)

Disease Duration (years)	5.60 (3.63)	6.21 (3.61)
Time Between Assessments (months)	N/A	7.35 (1.93)
Insulin Pump Regimen	97 (88%)	72 (89%)
Multiple Daily Injections Regimen	13 (12%)	9 (11%)
Hollingshead Index	46.56 (10.27)	46.25 (10.54)
Marital Status		
Married	82 (74.5%)	60 (74%)
Single	8 (7.4%)	6 (7.4%)
Divorced	13 (11.8%)	10 (12.3%)
Engaged/Living with	3 (2.7%)	2 (2.5%)
Separated	2 (1.8%)	1 (1.2%)
Widowed	2 (1.8%)	2 (2.5%)

Table 2. Means and Standard Deviations of Outcome Expectancy Constructs and Diabetes Outcomes.

	Mean $\pm$ SD	
	Baseline (Time 1)	6-month follow-up (Time 2)
Hope Scores (CHS)	27.00 (4.50)	27.70 (4.80)
Optimism Scores (LOT-R)	15.60 (4.79)	15.73 (4.82)
Self-Efficacy for Diabetes (SED)		
SED Total Scale	166.25 (18.73)	172.54 (17.97)
SED Diabetes-Specific	120.08 (14.09)	124.48 (14.23)
SED Medical	23.46 (4.26)	24.37 (3.35)
SED General	22.72 (4.04)	23.69 (3.41)



HbA1c	9.14 (2.17)	8.65 (1.53)
SMBG (Total checks over 14 days)	54.77 (31.81)	54.12 (30.42)

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## Preliminary Analyses

An ANOVA, a chi-square test, and linear regression analyses were used to determine whether any child demographic variables (ethnicity, gender, age, and disease duration) were significantly associated with study variables. As originally hypothesized, age was positively and significantly associated with HbA1c ( $R = 0.265, p < 0.01$ ), and was left in the proposed structural model as a covariate. No other demographic variable was significantly associated with outcome expectancy constructs or health outcomes.

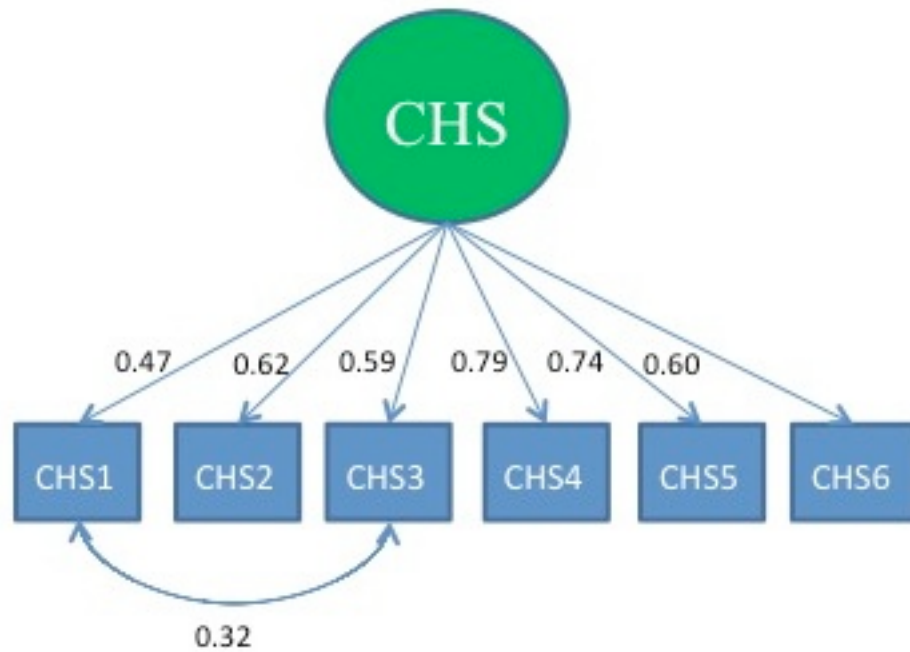
Consistent with study hypotheses, a small percentage of values were missing from the final dataset (i.e., 7.8%). Little's MCAR test (Little, 1998) supported the assumption that missing data were MCAR ( $\chi^2 = 1406.895, df = 1499, p = 0.956$ ).

## Measurement Model Analyses

Confirmatory factor analysis (CFA) supported the original factor structure of the CHS, demonstrating excellent model fit ( $\chi^2 = 8.08, p = 0.43$ ; RMSEA = 0.009; SRMR = 0.05; CFI = 0.999). Modification indices following estimation in MPlus indicated that model fit would be improved by adding a parameter estimation representing the residual association between CHS1 and CHS3 to the model. This suggests that the unexplained variance between each of these items – after accounting for the variance that is due to the latent variable – overlaps considerably. Further, an examination of a two-factor model of hope (agency and pathways latent constructs) yielded results suggesting that it is not tenable for this dataset (latent covariance matrix was not positive definite), and thus the one-factor model is a better fit to the data. Longitudinal invariance of the one-factor CHS was supported through tests of configural invariance ( $\Delta\chi^2 =$

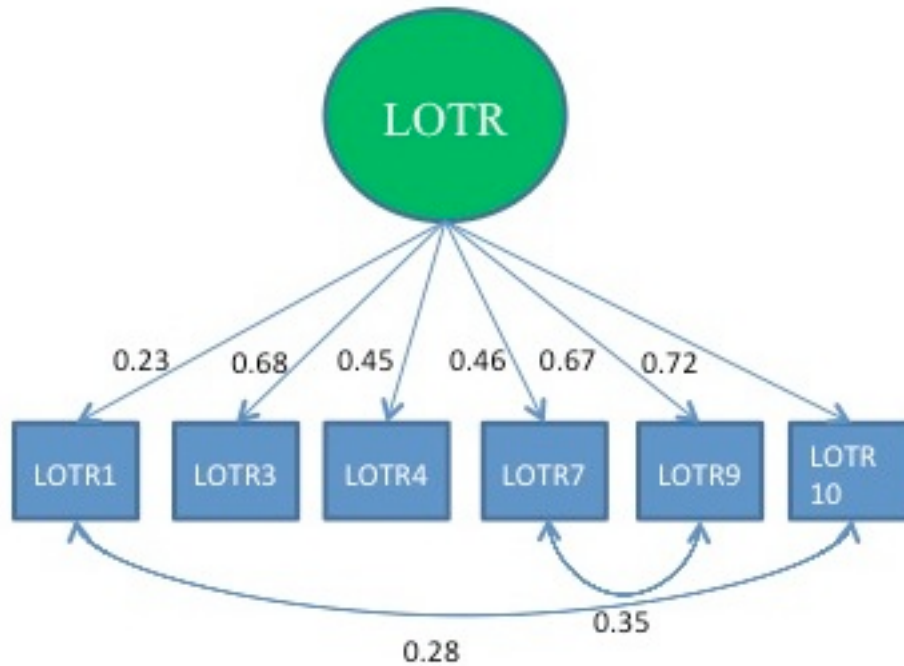
3.82,  $df = 6$ ,  $p > 0.25$ ), weak factorial invariance ( $\Delta\chi^2 = 1.56$ ,  $df = 5$ ,  $p > 0.25$ ), and strong factorial invariance ( $\Delta\chi^2 = 23.06$ ,  $df = 22$ ,  $p > 0.25$ ).

Figure 3. *Measurement Model of the Children's Hope Scale (CHS) for the Study Sample.*



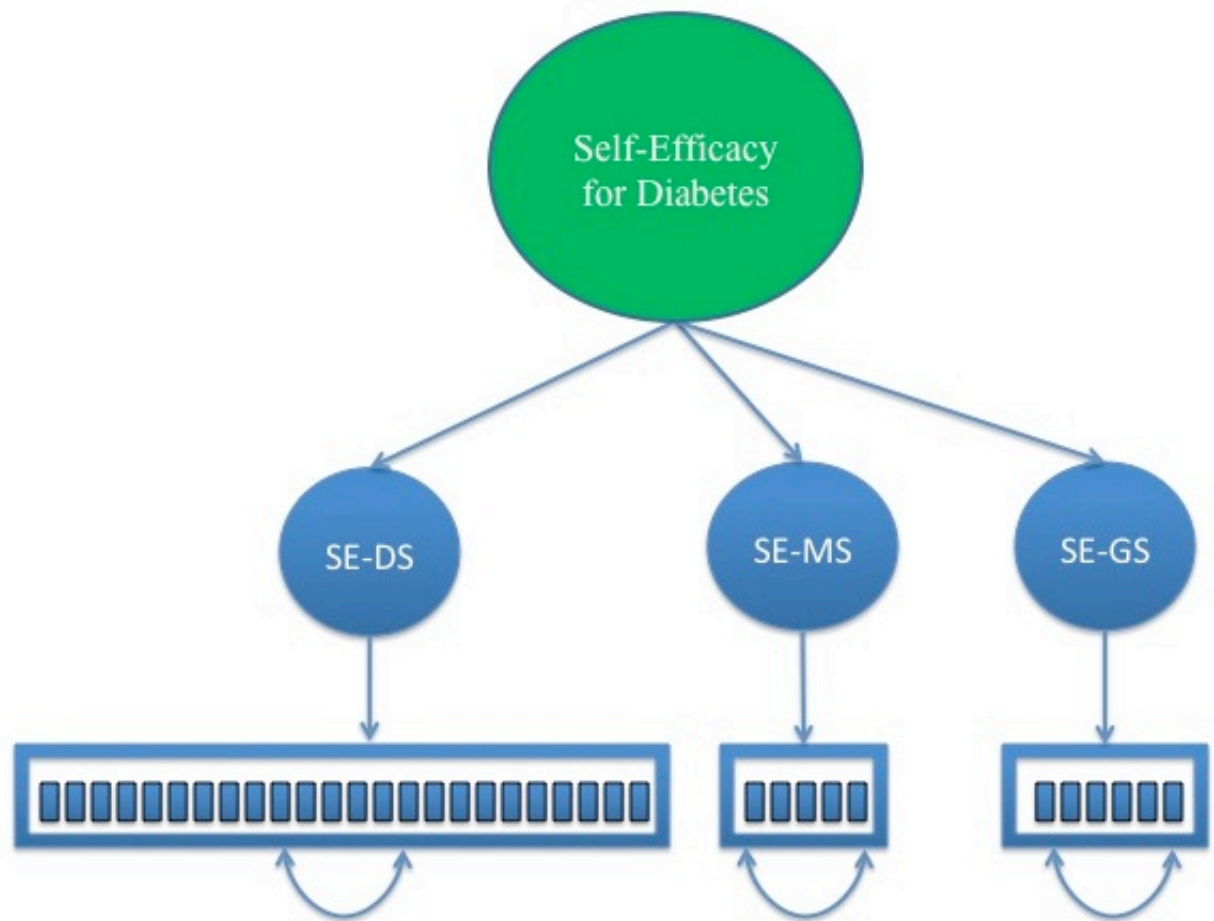
Results from a confirmatory factor analysis of the LOT-R also demonstrated good fit to the data ( $\chi^2 = 12.20$ ,  $p = 0.09$ ; RMSEA = 0.08; SRMR = 0.104; CFI = 0.96). Similar to the CFA of the CHS, the modification indices recommended estimating the indicator residuals between LOTR7 and LOTR9, and LOTR1 and LOTR10 given their overlap. Longitudinal invariance of the one-factor LOTR was supported through tests of configural invariance ( $\Delta\chi^2 = 9.88$ ,  $df = 9$ ,  $p > 0.25$ ), weak factorial invariance ( $\Delta\chi^2 = 12.90$ ,  $df = 7$ ,  $p > 0.25$ ), and strong factorial invariance ( $\Delta\chi^2 = 1.91$ ,  $df = 18$ ,  $p > 0.25$ ).

Figure 4. *Measurement Model of the Life Orientation Test-Revised (LOT-R) for the Study Sample.*



In contrast to the CHS and LOT-R, a confirmatory factor analysis of the SED demonstrated poor fit to the data overall, using either the three-factor structure as proposed by Grossman et al. (1987;  $\chi^2 = 513.19$ ,  $p < 0.001$ ; RMSEA = 0.064; SRMR = 0.114; CFI = 0.78) or a more parsimonious one-factor model ( $\chi^2 = 151.52$ ,  $p < 0.001$ ; RMSEA = 0.085; SRMR = 0.18; CFI = 0.82). Further, an exploratory factor analysis was unable to identify a set of items that would provide an acceptable model fit overall, even after removing items that may be less relevant to diabetes control today (e.g., such as items that reference checking glucose levels in urine). Given these results, the SED was not included in subsequent study analyses.

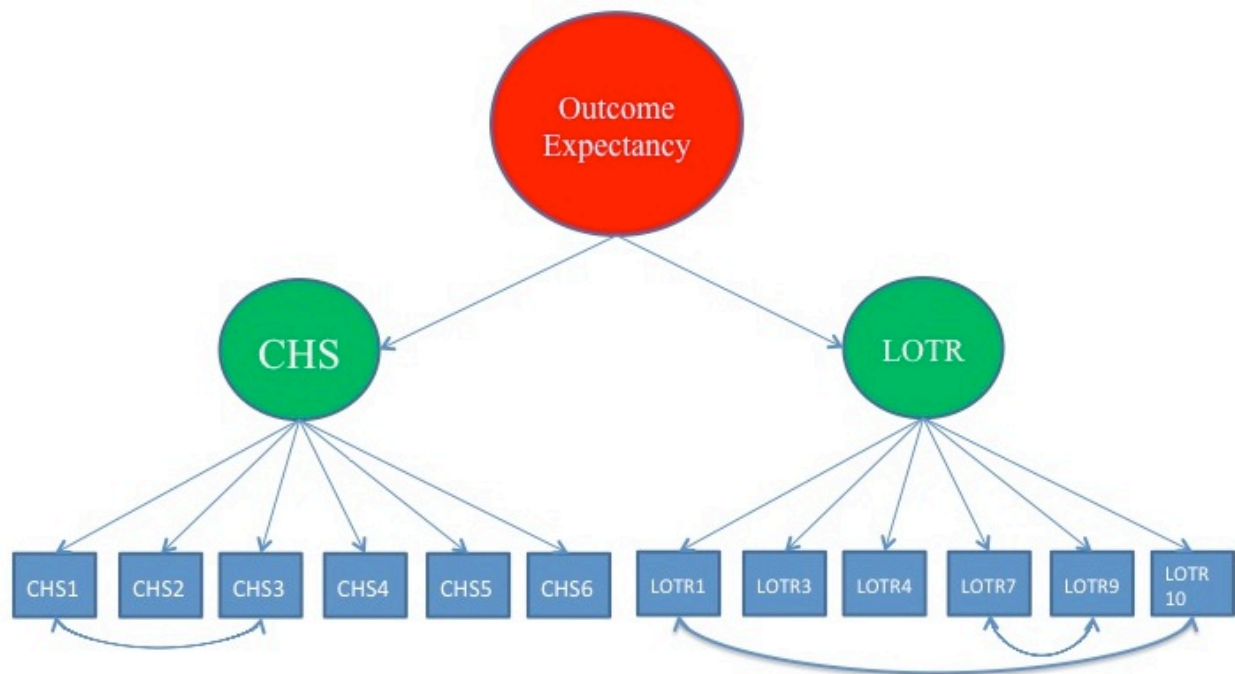
Figure 5. *Measurement Model of the Self-Efficacy for Diabetes (SED) for the Study Sample.*



Finally, a confirmatory factor analysis did not support a hierarchical second-order model including the CHS and LOTR. Despite acceptable fit to the data ( $\chi^2 = 80.71$ ,  $p < 0.01$ ; RMSEA = 0.071; SRMR = 0.079; CFI = 0.90), the variance of the second-order latent factor (i.e., Outcome Expectancy) was not significant. This suggests that the second-order latent factor does not represent a large portion of the variance of each construct in a meaningful way. Rather, only a non-significant portion of the variance between the CHS and LOTR can be attributed to a second-order factor. Alternatively, results indicated that the two-factor lower-order solution is an

acceptable fit to the data ( $\chi^2 = 80.77$ ,  $p < 0.01$ ; RMSEA = 0.073; SRMR = 0.12; CFI = 0.90), but the overall fit of this model was significantly worse than the fit of each model separately (CHS:  $\Delta\chi^2 = 79.19$ ,  $df = 5$ ,  $p < 0.05$ ; LOTR:  $\Delta\chi^2 = 68.57$ ,  $df = 4$ ,  $p < 0.05$ ). Thus, separate one-factor models were deemed more appropriate and parsimonious for this sample.

Figure 6. *Proposed Measurement Model of the Second-Order Outcome Expectancy Factor.*



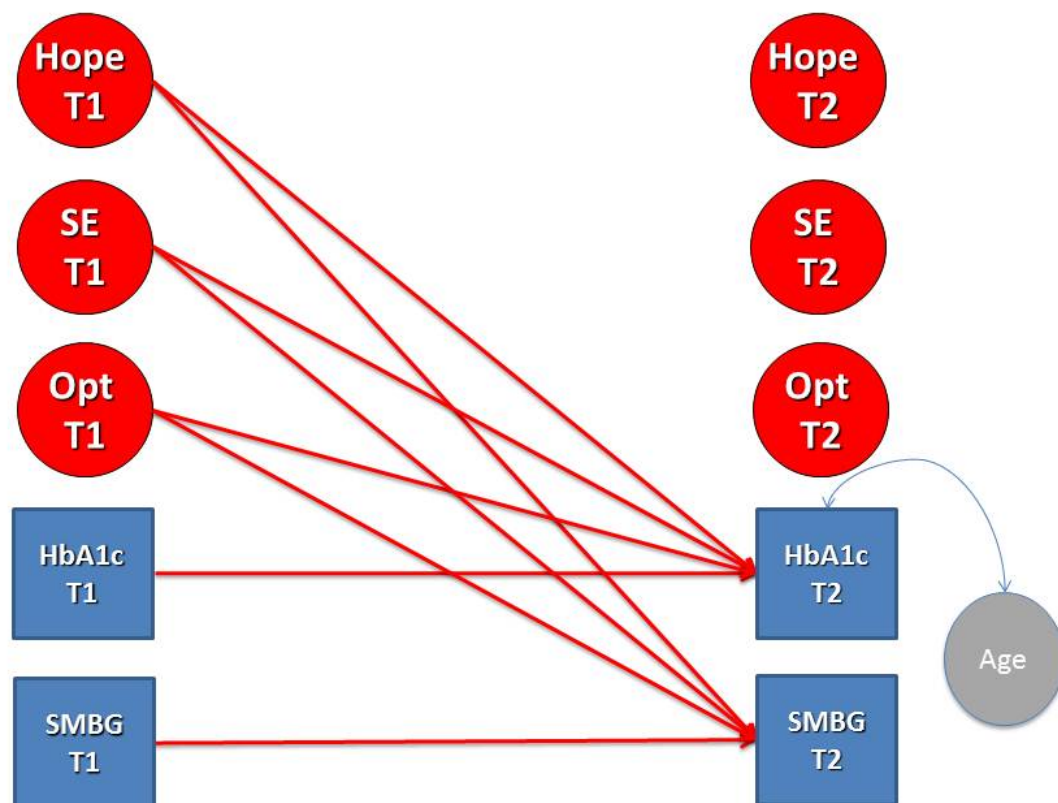
### Longitudinal Structural Models

The simultaneous associations (i.e., cross-lagged analyses) between Time 1 CHS and LOTR as predictors of residual change in SMBG and HbA1c, as well as Time 1 SMBG and HbA1c as predictors of residual change in CHS and LOTR were analyzed. Age was included as a covariate in the structural model. The SED was excluded from the originally proposed model

given that its factor structure was not supported by a confirmatory factor analysis and a model of acceptable fit could not be identified via exploratory factor analysis.

The longitudinal structural model of the associations between Time 1 CHS and LOTR, and residual change (Time 2 regressed onto Time 1) in SMBG and HbA1c, resulted in a poor fitting model overall ( $\chi^2 = 402.67, p < 0.001$ ; RMSEA = 0.13; SRMR = 0.11; CFI = 0.72) with no significant pathways between outcome expectancy constructs and residual change in HbA1c or SMBG.

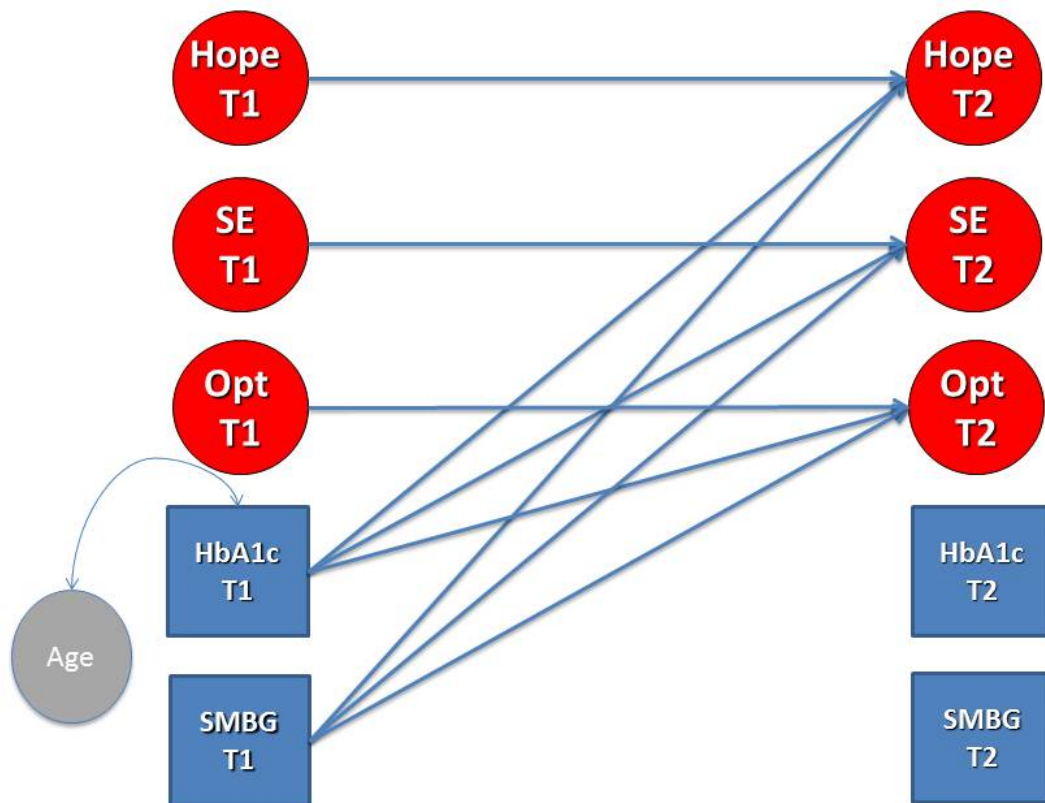
Figure 7. *Longitudinal Structural Model of CHS, SED, and LOT-R Scores Predicting Residual Change in HbA1c and SMBG.*



*Note.* None of the above pathways were statistically significant, and are included only as representations of the tested model.

The longitudinal structural model of the associations between Time 1 SMBG and HbA1c and residual change in hope and optimism could not converge using the available dataset. Low estimation power is a common reason for model estimation failure, and the limited number of participants at Time 2 resulted in lower statistical power than originally planned.

Figure 8. *Longitudinal Structural Model Depicting HbA1c and SMBG Predicting Residual Change in CHS, SED, and LOT-R Scores.*



*Note.* None of the above pathways were statistically significant, and are included only as representations of the tested model.

### Post-Hoc Analyses

Although the original longitudinal structural models did not support study hypotheses, post-hoc analyses were conducted based on a variety of possible explanations for the above

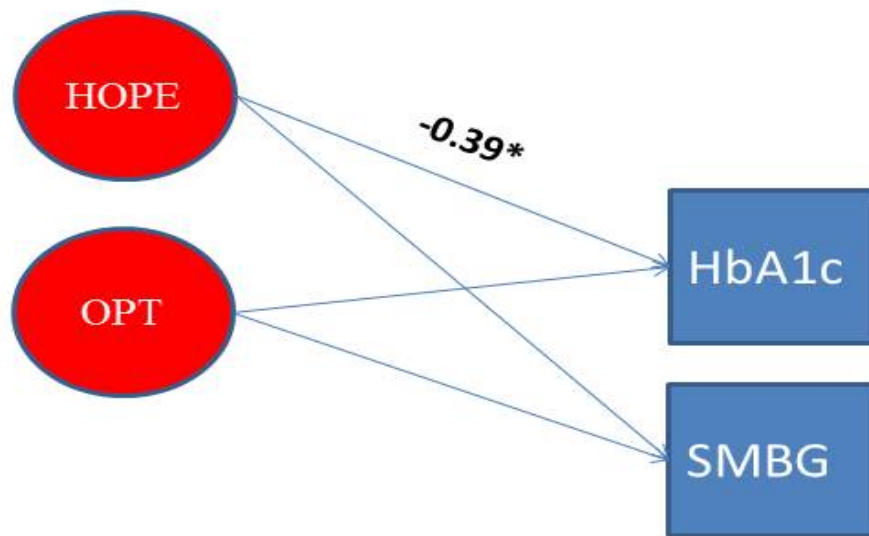
findings. For example, it is possible that Time 1 values of CHS and LOTR were not associated with residual change in SMBG and HbA1c because the proposed associations would be better conceptualized by change associations in each variable. A post-hoc analysis of the association between *residual change* in hope and optimism, and *residual change* in SMBG and HbA1c failed to converge.

Moreover, given that self-monitored blood glucose (SMBG) is often conceptualized as a proxy for adherence to T1DM treatment (Helgeson et al., 2011), a post-hoc test of mediation was conducted with SMBG serving as a mediator of the relationship between outcome expectancy constructs and HbA1c. Based on recommendations from MacKinnon (2008) regarding mediation analyses with two time points, the mediation model was tested using auto-regressive change scores of each variable. Similar to the previous change model explained above, the estimation failed to converge.

Given that longitudinal models were restricted in their ability to detect statistical significance due in part to limited statistical power, conceptually similar cross-sectional models were estimated using Time 1 data. The cross-sectional panel model testing the association between hope and optimism, and SMBG and HbA1c is depicted below.



Figure 9. *Time 1 Cross-sectional Model Depicting CHS and LOT-R Scores Predicting HbA1c and SMBG.*



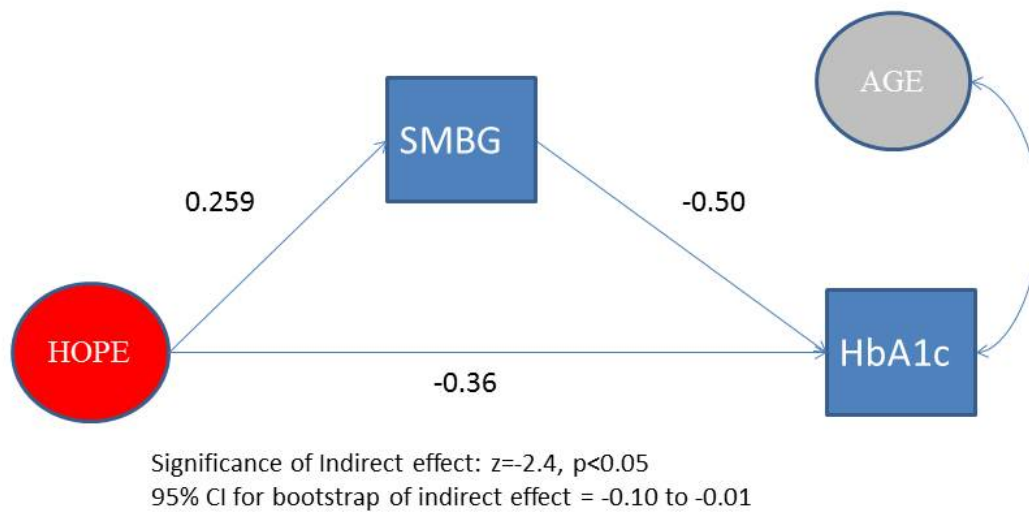
*Note.* Values represent the standardized estimate of the structural path. Nonsignificant values have been pruned from the model. \* $p < 0.05$

The cross-sectional model demonstrated good overall fit ( $\chi^2 = 102.21, p < 0.05$ ; RMSEA = 0.058; SRMR = 0.075; CFI = 0.92), with a statistically significant estimated loading between hope and HbA1c ( $-0.39, p < 0.05$ ).

Similarly, a cross-sectional mediation model was estimated with SMBG serving as the mediator between hope and HbA1c and between optimism and HbA1c. Significant indirect effects were found for each analysis, suggesting that SMBG may mediate the relationship between both hope and HbA1c ( $z = -2.35, p < .05$ , 95% CI for bootstrap of indirect effect = -

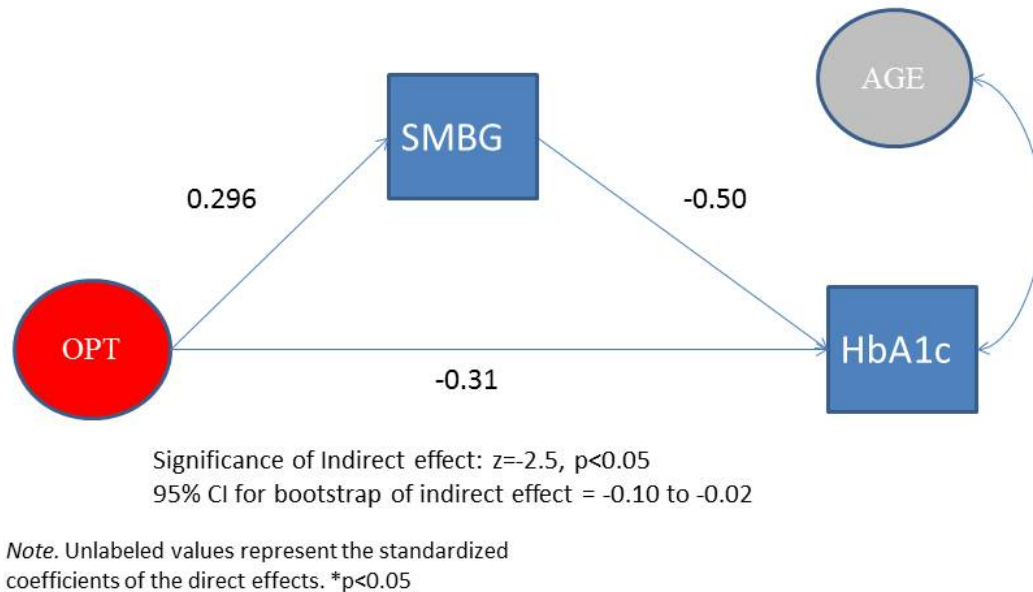
0.10 to -0.01), and optimism and HbA1c ( $z = -2.51, p < .05$ , 95% CI for bootstrap of indirect effect = -0.10 to -0.02).

Figure 10. *Time 1 Cross-sectional Mediation Model Depicting SMBG as a Mediator of CHS Scores and HbA1c.*



Note. Unlabeled values represent the standardized coefficients of the direct effects. \* $p < 0.05$

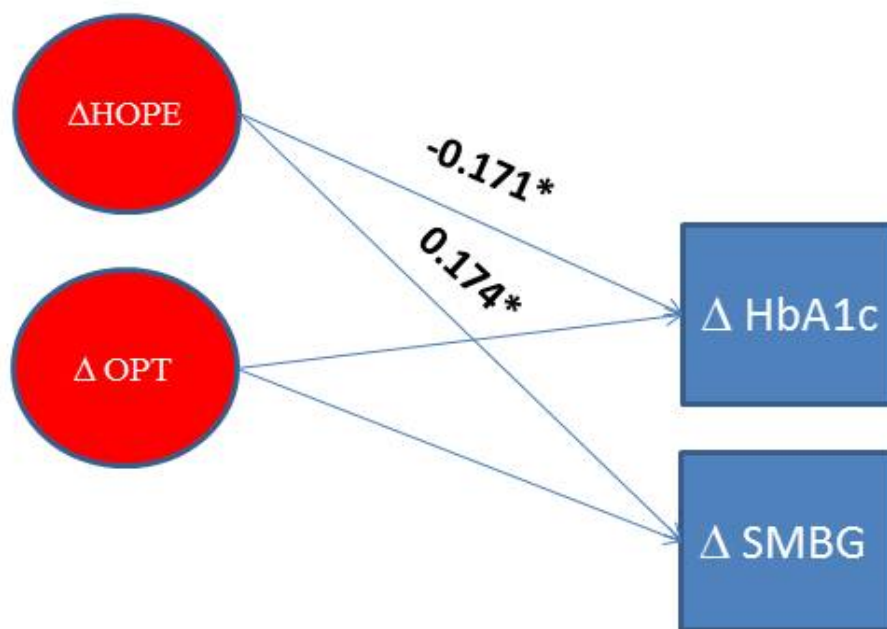
Figure 11. *Time 1 Cross-sectional Mediation Model Depicting SMBG as a Mediator of LOT-R Scores and HbA1c.*



Finally, in response to the difficulties obtaining convergence for the longitudinal models described above, multiple hierarchical regressions were tested as an alternative method of statistical analysis. Specifically, age was entered into the first step of each regression testing CHS and LOTR as a predictors of HbA1c. In order to demonstrate change in HbA1c over time, Time 1 HbA1c was entered into Step 2 of the regression, with Time 2 HbA1c set as the dependent variable. The same process was used for regression analyses that included SMBG, rather than HbA1c, as the target outcome variable. Time 1 CHS and LOTR scores were entered in the final step of the hierarchical regressions testing whether Time 1 scores for these variables predicted change in the outcome variables over time. Alternatively, for the longitudinal change regression analyses, change in either CHS and LOTR were entered in the final step (of separate regressions), and these change variables were calculated by regressing Time 2 CHS or LOTR onto Time 1 CHS or LOTR and subsequently saving the standardized residuals, which served as

the change predictor variables. Results indicated that Time 1 hope and optimism were not significant predictors of change in HbA1c or SMBG. On the other hand, change in hope was a significant predictor of change in both HbA1c ( $R^2\Delta = .030$ ,  $\Delta F [1,73] = 3.95$ ,  $p < 0.05$ ) and SMBG ( $R^2\Delta = .031$ ,  $\Delta F [1,64] = 4.29$ ,  $p < 0.05$ ), while change in optimism did not predict change in either outcome variable.

Figure 12. *Time 1 Cross-sectional Model Depicting CHS and LOT-R Scores as Predictors of HbA1c and SMBG.*



*Note.* Values represent the standardized coefficient of the regression model. Nonsignificant values were pruned from the model.  $^*p < 0.05$

Table 3. *Summary of hierarchical multiple regression analyses.*

Dependent Variable and Block	B	SE B	$\beta$	$\Delta R^2$	$\Delta F$
<b>HbA1c at Time 2</b>					
Step 1 (Age)				.113	13.245*
Age	.257*	.064	.338		
Step 2 (T1 HbA1c)				.490	71.926**
T1 HbA1c	0.481**	.057	0.700		
Step 3 (Hope)				.030	3.947*
Change in CHS Scores	.159*	.068	.237		
<b>HbA1c at Time 2</b>					
Step 1 (Age)				.101	12.944*
Age	.249*	.062	.320		
Step 2 (T1 HbA1c)				.449	56.975**
T1 HbA1c	0.470**	.062	0.670		
Step 3 (Optimism)				.000	0.27
Change in LOTR Scores	.023	.138	.015		

### SMBG at Time 2

Step 1 (T1 SMBG)				.489	63.178**
T1 SMBG	0.653**	.082	0.699		
Step 2 (Hope)				.031	4.29*
Change in CHS Scores	6.091*	2.685	.198		

### SMBG at Time 2

Step 1 (T1 SMBG)				.461	52.946**
T1 SMBG	0.629**	.087	0.679		
Step 2 (Optimism)				.003	0.294
Change in LOTR Scores	1.528	2.820	.05		

\* $p < .05$ ; \*\* $p < .01$

A mediation model of longitudinal change did not detect a significant indirect effect of SMBG as a mediator of the relationship between outcome expectancy constructs and HbA1c.

### **Discussion**

This study was designed to test the relative associations between three conceptually similar constructs (hope, self-efficacy, and optimism) and longitudinal change in HbA1c and frequency of blood glucose monitoring over a period of approximately six months. Results partially supported study hypotheses. The factor structure of measures of children's hope and children's optimism were confirmed in a sample of children with diabetes, but the factor structure of a diabetes self-efficacy measure was poor and, as a result, was excluded in subsequent structural models. Further, the test of a second-order factor made up of items from the CHS and LOTR was not supported; although model fit was acceptable for the single second-order factor, the hierarchical latent factor had limited variance with which to test structural models. The two-factor lower-order model demonstrated acceptable fit, but the overall fit of each construct modeled separately was significantly better than the fit of a model that included both constructs modeled together.

Initial analyses indicated that neither children's hope nor children's optimism were significant predictors of longitudinal change in either HbA1c or blood glucose monitoring, and tests of longitudinal change models and longitudinal mediation were not supported by the data. It is important to note, however, that longitudinal analyses were limited by the reduced power to detect statistical significance at Time 2 due to study attrition. This attrition was primarily the result of research assistants being unavailable for data collection during the summer of 2012 when many patients were scheduled for their next clinic visit. There were 81 participants who completed Time 2 analyses, fewer participants than necessary according to power analyses of the

proposed structural model which indicated that 87 participants were necessary to achieve a close fit to the data with power set to .80 and alpha set to .05 (Preacher & Coffman, 2006).

Post-hoc analyses of time 1 data indicated that children's hope was significantly associated with HbA1c in a cross-sectional structural model, and analyses supported a cross-sectional mediation model that included self-monitored blood glucose checks (SMBG; i.e., an adherence proxy) as a mediator of the relationship between children's self-reported hope and their HbA1c. Conversely, children's optimism was not directly associated with their HbA1c; however, analyses supported an indirect model in which SMBG served as mediator of the relationship between optimism and HbA1c. Neither children's hope nor children's optimism were associated with blood glucose monitoring (i.e., SMBG) in the cross-sectional structural model. Although the longitudinal structural models were restricted by low statistical power, post-hoc longitudinal analyses using hierarchical multiple regressions were tested in place of structural models. Results supported a longitudinal change model, in which changes in hope were associated with changes in both HbA1c and SMBG.

A variety of conclusions are available from the above results. First, with regard to initial measurement confirmation, the Self-Efficacy for Diabetes scale (SED) may not be an appropriate measure of self-efficacy in youths with type 1 diabetes. The original validation study did not use exploratory factor analysis or confirmatory factor analysis to examine the latent structure or individual item loadings (Grossman et al., 1987). Instead, authors relied on Kuder-Richardson coefficient alphas to establish reliability of the overall measure and each subscale, and examined associations between the SED (and subscales) and similar measures as support for criterion-related validity. Factor analysis is generally considered the most effective method of establishing construct validity because it allows researchers to evaluate a model while mathematically



controlling for measurement error at the indicator level (Brown, 2006). By not including factor analysis as part of the measurement validation process, it is possible that a measure's reliability and latent associations with similar constructs are due to consistencies in error variance rather than in true construct variance.

Beyond methodological issues in the confirmation of the SED, the measure's content validity may not adequately reflect current treatment requirements. More specifically, when examining the face validity of various items from the SED, it is likely that a number of items may have directly contributed to poor model fit because they are unlikely to be relevant to youths with T1DM today. For example, one item asks children to rate how much they believe they can monitor their own glucose levels in their urine; however, urine tests are rarely conducted at home or in diabetes clinics, and an item assessing this behavior may be interpreted inconsistently across study participants.

The argument could be made that the poor performance of the SED was a result of inadequate sample size, and not the result of item irrelevancy. Although this is often a valid criticism of CFA analyses, in the current case, it does not seem likely. Despite a limited number of participants at Time 2, study sample size at Time 1 (i.e., 110 participants) provided adequate statistical power to assess model fit. Thus, an exploratory factor analysis was conducted in order to identify a set of items that would result in a good fitting model. Unfortunately, an exploratory factor analysis could not identify a set of items that effectively represented the latent construct from the available indicators, even after removing items that may not be relevant to children today.

This investigation also contributes to the growing literature aimed at distinguishing hope and optimism, and the impact of these constructs on individual functioning. Researchers such as

Aspinwall and Leaf (2002), Peterson and Seligman (2004), and Tennen (2002) have questioned whether hope is distinct from optimism, and whether it contributes uniquely to the field. In response, Rand (2009) compared the factor structure of the Hope Scale (Snyder et al., 1991) and a measure of optimism among a sample of adults, and found that a second order latent factor combining both measures was a better representation of the data than each latent factor modeled separately. The current analyses examined whether a second order hierarchical latent factor consisting of hope and optimism was a better fit to the data than alternative models among youths. Results indicated that the single higher-order model and the lower-order two-factor model demonstrated acceptable fit to the data overall, but the original measurement models (i.e., each construct measured separately) were a better representation of the data based on statistical comparisons of fit.

As noted above, previous research has suggested that hope and optimism may overlap to such a degree that they are better conceptualized as contributors to a second-order latent factor (Rand, 2009). The contrast between the results of the present study and Rand (2009) may be explained by differences in instrumentation. For example, Rand (2009) used the adult version of the Hope Scale (Snyder et al., 1991), while the present study used the CHS (Snyder et al., 1997). Thus, because the same measure of optimism used by Rand (2009) was also used in this study (i.e., LOTR), the differences in factor structures may be better explained by differences in measures used to obtain estimates of self-reported hope. Alternatively, the differences between study results regarding construct overlap may be the result of conceptual differences in the experience of optimism and hope across developmental levels (i.e., children and adolescents vs. adults). For example, youths may report a more homogeneous optimistic outlook on the future than adults, but may have had a sufficiently heterogeneous set of experiences in the goal-

attainment process to respond with more variance in that context. However, it is important to note that no study could be identified which examines the longitudinal variance of hope and optimism measures from childhood to adulthood.

It may be the case that these findings are not generalizable to differences between youths and adults, or between hope measures, and apply only to differences between the adult participants from Rand's study and the youths with T1DM in the present investigation. As mentioned previously, youths with T1DM have an extensive daily treatment regimen that requires persistence (e.g., checking blood sugars numerous times a day, every day) and frequent problem solving (e.g., adjusting insulin appropriately). Thus, the processes underlying agency- and pathways-related behavior may be more salient to youths' with T1DM, which may influence youths with T1DM to develop a more distinct conceptualization between hope and optimism. Moreover, this finding may not be exclusive to comparisons between adults and children with T1DM; adults with T1DM may also report differences in hope compared to healthy adult counterparts.

Results from the current cross-sectional structural models, mediation analyses, and longitudinal change models suggest that hope may be an important factor in youths' glycemic control. The current results are consistent with Lloyd et al.'s (2009) investigation examining the role of hope among adolescents with T1DM, and expanded upon this work by (1) testing longitudinal associations, (2) incorporating school-aged children as well as adolescents, and (3) using structural models to test latent construct associations. The present results are also consistent with numerous published studies establishing an association between hope and health outcomes in pediatric psychology (Berg et al., 2007; Maikranz et al., 2007; Van Allen & Steele, 2012).

Similar to these previous studies, the present study found that changes in hope were associated with changes in adherence and HbA1c. These results suggest that interpretations of hope as a trait construct that predicts changes in health outcomes over time (e.g., Berg et al., 2011) may not be accurate, and that the associations between hope and health outcomes over time may depend on a related change in each. The present study also supported hope's indirect effect on HbA1c through adherence (i.e., SMBG) in a cross-sectional mediation. Therefore, a majority of the association between CHS and HbA1c can be explained by how hope influences blood-glucose monitoring: youths who report higher hope also check their blood glucose more frequently, and are more likely to have a lower HbA1c as a result.

Although a cross-sectional structural model, longitudinal regression analyses, and longitudinal change analyses did not reveal statistically significant direct associations between optimism and SMBG or HbA1c, a cross-sectional test of mediation suggests that optimism may have a significant indirect effect on youths' HbA1c through their blood glucose monitoring. This finding is consistent with the current published literature, as no other study could be identified through a literature search that reported a significant direct effect of optimism, as measured by the LOTR, on HbA1c (Wright, 1997). In other words it may be the case that optimism has an effect on HbA1c only in so much as it has an effect on adherence (i.e., SMBG), and that it does not have a direct effect overall.

When study results related to hope and optimism are considered together, they suggest that hope may have a greater impact on youths' glycemic control in comparison to optimism. Although some previous studies have suggested that optimism adds additional predictive power beyond that of hope (e.g., Vacek et al., 2010), other investigations have found hope to predict outcomes equal to, or better than, optimism (Bailey et al., 2007; Magaletta & Oliver, 1999;

Rand, 2009; Synder et al., 2002; Wong & Lim, 2009). Theoretically, hope may have a greater impact on diabetes management because it purports to assess how one engages in goal-directed behavior and maintains energy throughout a goal pursuit, rather than simply assessing one's outcome expectancies. Stated simply, diabetes management is onerous enough that it requires considerable cognitive and emotional resources, and hope theory may tap into more of those resources than optimism.

### **Clinical Implications**

Results of the current study indicate that hope and optimism may be important factors to consider when treating youths with T1DM, and that hope may be particularly important when considering health change processes. In fact, previous research has found that changes in hope are temporally associated with changes in health outcomes, such as physical activity (Van Allen & Steele, 2012). Previous studies have also reported observing changes in hope for children and adolescents over the course of intervention efforts (McNeil et al., 2006; Van Allen & Steele, 2012; Weis & Ash, 2010); however, it is important to note that none of these studies specifically aimed to increase hope through targeted intervention. While such studies do not support a directional relationship between hope and treatment outcomes, other hope-based interventions have demonstrated success and have been associated with subsequent reductions in emotional stressors (Berg et al., 2008; Cheavens et al., 2006; Curry & Maniar, 2003; Duggleby et al., 2007). Within the health context, for example, Berg and colleagues (2008) reported significant increases in hope among females, and significant increases in pain tolerance for all participants, following a brief hope intervention for a cold pressor task. Thus, psychosocial treatment efforts may benefit from incorporating hope treatment components within their framework. To date, no study has utilized an experimental design to test the effects of an intervention targeting increases

in hope or optimism among youths with T1DM. A study of this kind is needed in order to determine whether such changes directly result in improvements to adherence or HbA1c. Study results also point to the potential importance of assessing hope and optimism as factors that may impact HbA1c through adherence. For example, clinicians may benefit from assessing these constructs in clinic-based psychosocial screenings to help identify new patients who may be at risk for poor metabolic control. The use of these measures for clinic screenings should be based on future research supporting their ability to consistently identify high risk patients.

### **Limitations**

Results of the current study should be considered within the context of a single study with methodological and statistical limitations. First, the Self-Efficacy for Diabetes scale was a poor fit to the study data, which prevented testing all proposed statistical models. Although an examination of the conceptual overlap between hope and optimism was possible, the overlap between self-efficacy for diabetes, hope, and optimism could not be tested. Therefore, specific questions regarding hope's unique contributions to outcomes beyond those attributed to self-efficacy (e.g., as called for by Tennen et al., 2002) remain unanswered in youths. Nonetheless, this study contributed to the literature on T1DM in youth by conducting the first CFA of the factor structure of the SED. Researchers interested in examining self-efficacy among youths with T1DM in the future may want to consider alternative measures, such as the Self-Efficacy for Diabetes Self-Management (SEDM; Iannotti et al., 2006), which has been used effectively in studies that analyzed data in an SEM framework.

Further, statistical analyses of longitudinal structural models could not be tested as originally planned due to limited statistical power. Moreover, post-hoc analyses of the original longitudinal panel model using hierarchical regression did not support study hypotheses.

Although longitudinal change models *were* supported, the inherent weaknesses of regression analyses still apply to interpretations of this finding (e.g., measurement error could not be controlled for during analyses). Nonetheless, these regression analyses provide some initial support of a prospective relationship between hope and health outcomes, and are consistent with a previous study indicating that longitudinal change models are a better representation of the relationship between hope and health behavior (Van Allen & Steele, 2012). Like Van Allen and Steele (2012), however, analyses included data from only two time points, which limited directional interpretations of results. For example, it cannot be conclusively inferred that changes in hope led to changes in health outcomes, rather than an alternative view that changes in health outcomes led to changes in hope.

In addition, although SMBG may serve as a proxy of adherence, it is not a comprehensive measure of adherence. Other behaviors are important to T1DM treatment regimens, such as appropriate insulin dosing and accurate carbohydrate counting. Thus, study results may not generalize to more comprehensive assessments of adherence in future research studies, or in clinic settings.

The generalizability of study findings are also restricted by the limited diversity of participants' self-reported ethnicity. Approximately 89% of parents in the study identified their child as Caucasian. However, current estimates suggest that approximately 75% of youths with T1DM are identified as Non-Hispanic White (Liese et al., 2006; Mayer-Davis et al., 2009). Thus, future studies should examine the relationship between outcome expectancy constructs and SMBG and HbA1c in a sample more accurately representative of youths with T1DM. Nonetheless, the socioeconomic status of this sample is similar to previous work (Swift et al., 2006). In addition, the mean HbA1c for this sample was higher at each time point (T1=9.14,

T2=8.65) than the estimated population mean from an epidemiological study (Petitti et al., 2009). Study findings may not generalize to samples with better HbA1c control. Finally, data collection of study measures using electronic tablets had not been validated prior to this study, and thus may not generalize to other investigations.

## **Conclusion**

Overall, this study adds to the pediatric diabetes literature in a variety of ways. First, analyses confirmed the factor structure of the CHS and the LOTR in a sample of youths with T1DM, and determined that the SED may not be an effective measure of diabetes self-efficacy. Second, this study found that hope was significantly associated with HbA1c cross-sectionally, and that changes in hope were associated with changes in HbA1c and SMBG prospectively over approximately 6 months. Third, both hope and optimism had significant indirect effects on HbA1c, through SMBG, in cross-sectional mediation models. Although longitudinal structural models were constrained by limited statistical power, cross-sectional results provide initial evidence for study hypotheses and elucidate potentially important factors for psychological treatment in the T1DM context. Future research should examine the role of self-efficacy in similar analyses, and test longitudinal associations using three time points to allow for more tenable interpretations of mediation models and directional inferences.



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